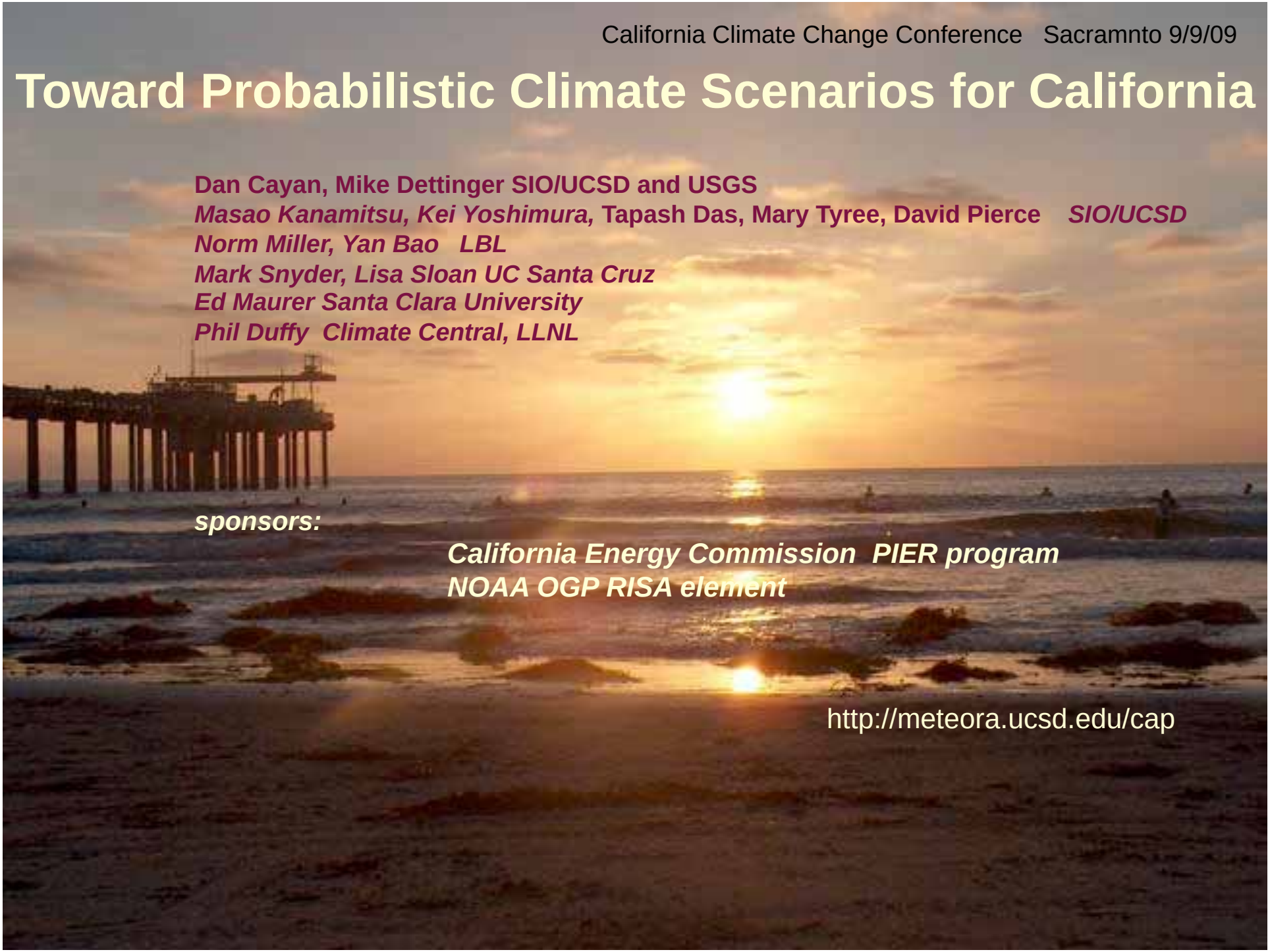


California Climate Change Conference Sacramnto 9/9/09

Toward Probabilistic Climate Scenarios for California

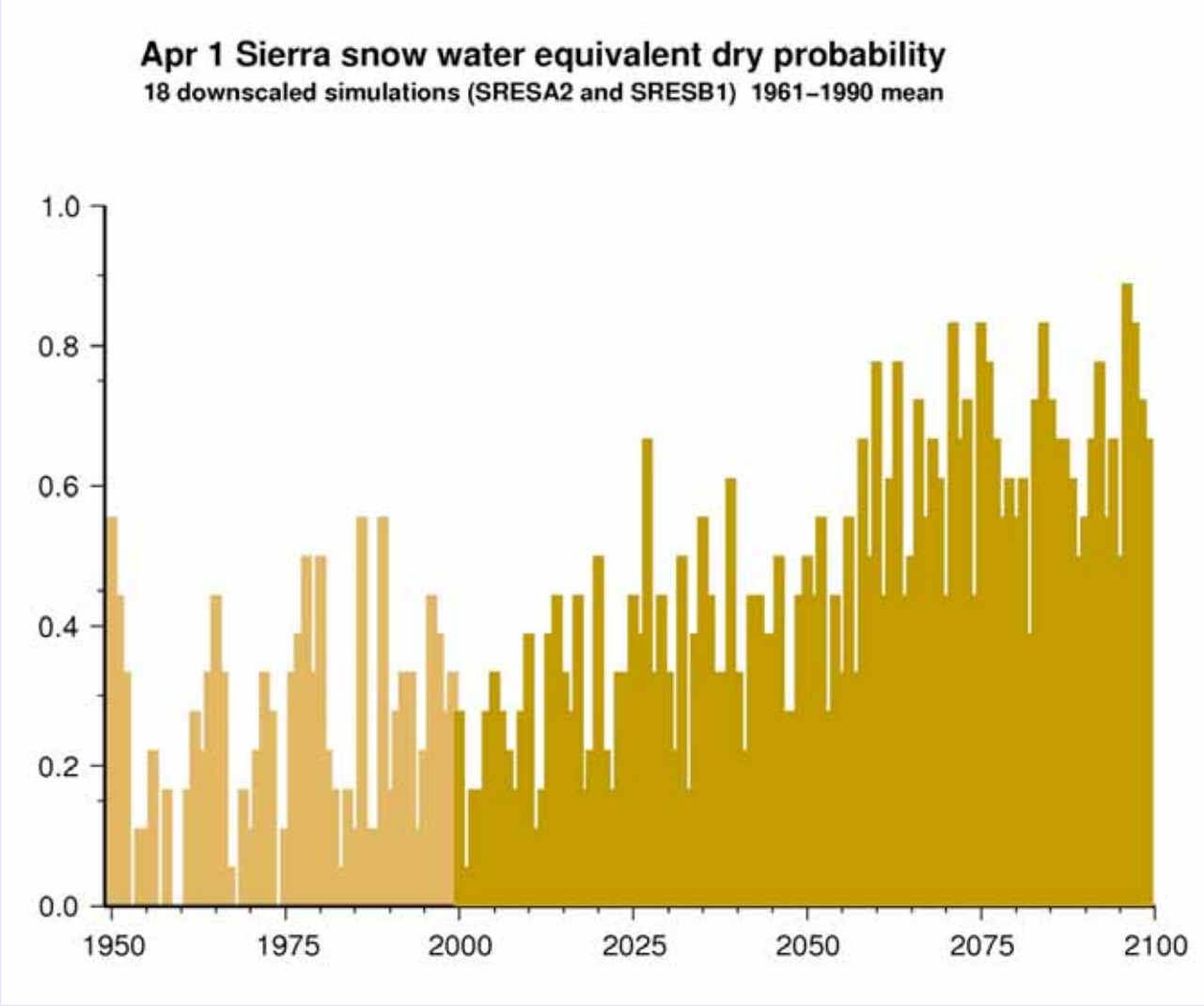
Dan Cayan, Mike Dettinger SIO/UCSD and USGS
Masao Kanamitsu, Kei Yoshimura,* Tapash Das, Mary Tyree, David Pierce *SIO/UCSD
Norm Miller, Yan Bao LBL
Mark Snyder, Lisa Sloan UC Santa Cruz
Ed Maurer Santa Clara University
Phil Duffy Climate Central, LLNL

sponsors:

California Energy Commission PIER program
NOAA OGP RISA element

http://meteora.ucsd.edu/cap

An educated guess: Probability of Low Sierra Nevada Snow



Approach—evaluate ensemble of estimates, from downscaled global climate simulations to California

Downscaling Groups: Three Dynamic and One Statistical

- **Berkeley Lab and UC-Berkeley: Miller,**

NCAR Weather Research and Forecasting Model with
(1) Rapid Update Cycle (WRF-RUC)
(2) Community and Model version 3 (WRF-CLM3)

- **UCSC: Snyder, Sloan**

ICTP Regional Climate Model Version 3 (RegCM3)

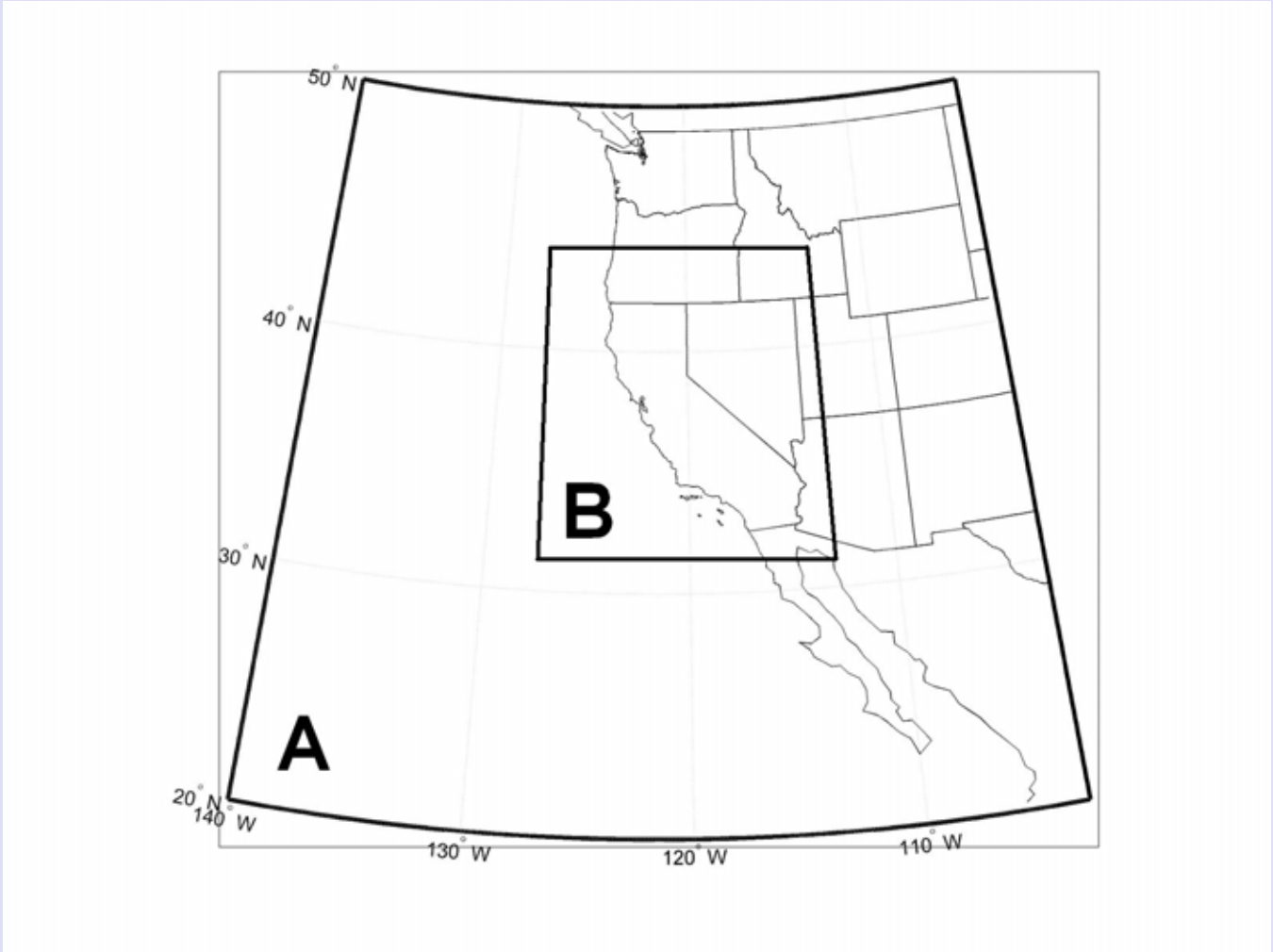
- **SIO/UCSD: Kanamitsu, Yoshimura**

NOAA Regional Spectral Model (RSM)

- **Santa Clara Univ/UCSD: Maurer, Das, Dettinger, Cayan**

Bias Corrected Spatial Downscaled andConstructed Analogues Statistical Model (BCSD/BCCA)

Model Domains and Resolutions



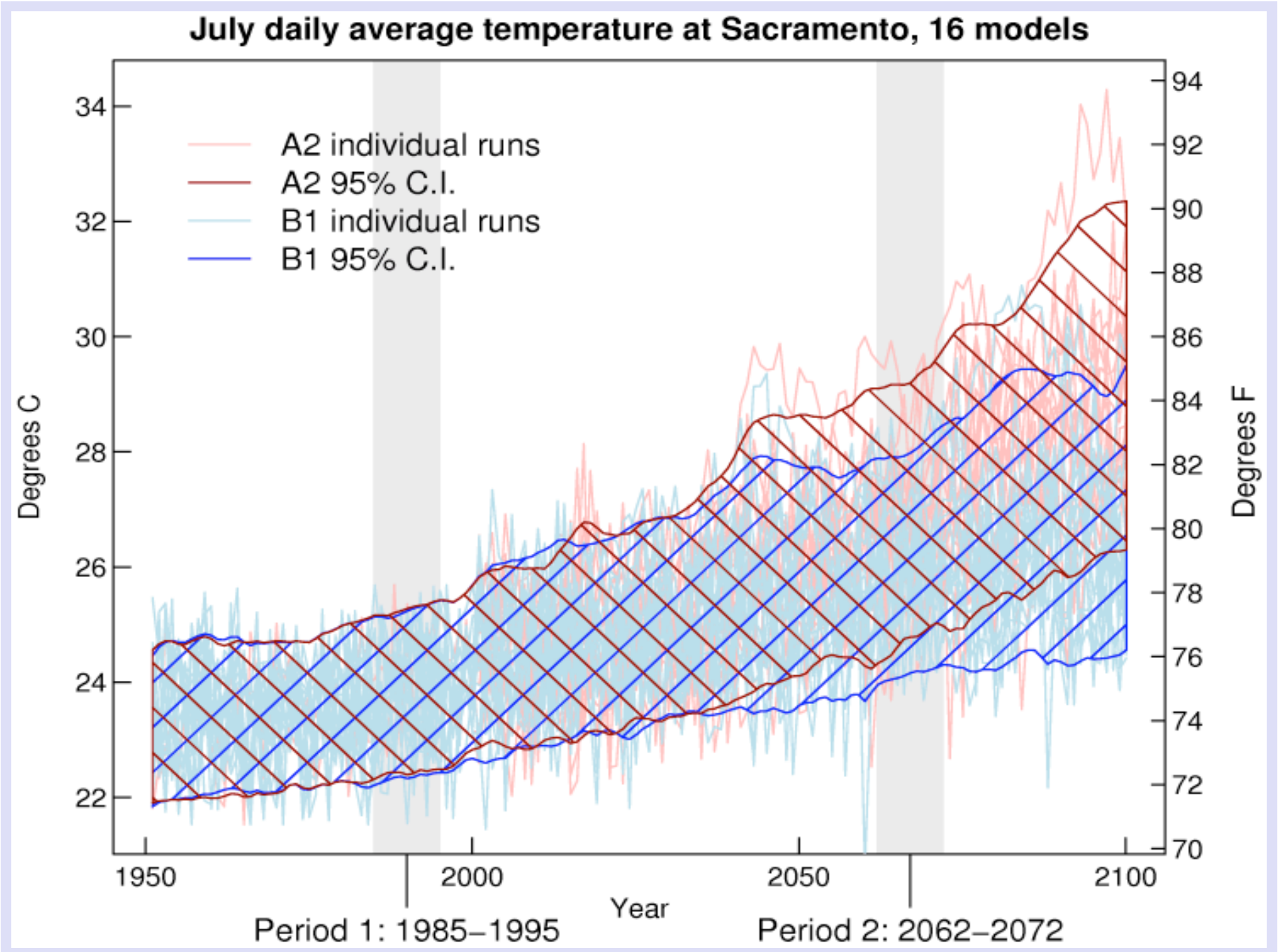
A - Western U.S. and Eastern Pacific Ocean, 30-km resolution, [139W21N x 104W51N]

B - California, Nevada, Eastern Pacific Ocean, 10-km resolution, [128W31N x 113W44N]

California Temperature change, end of 21st century vs. historical response

		Global Climate Models					
		NCAR PCM1	GFDL CM 2.1	NCAR CCSM3	ECHAM5/ MPI-OM	MIROC 3.2	CNRM CM3
Emissions Scenarios	A2 (mid-high)	2.6	4.5	4.2	3.8	4.8	3.9
	B1 (lower)	1.6	2.7	2.4	2.8	3.3	2.2

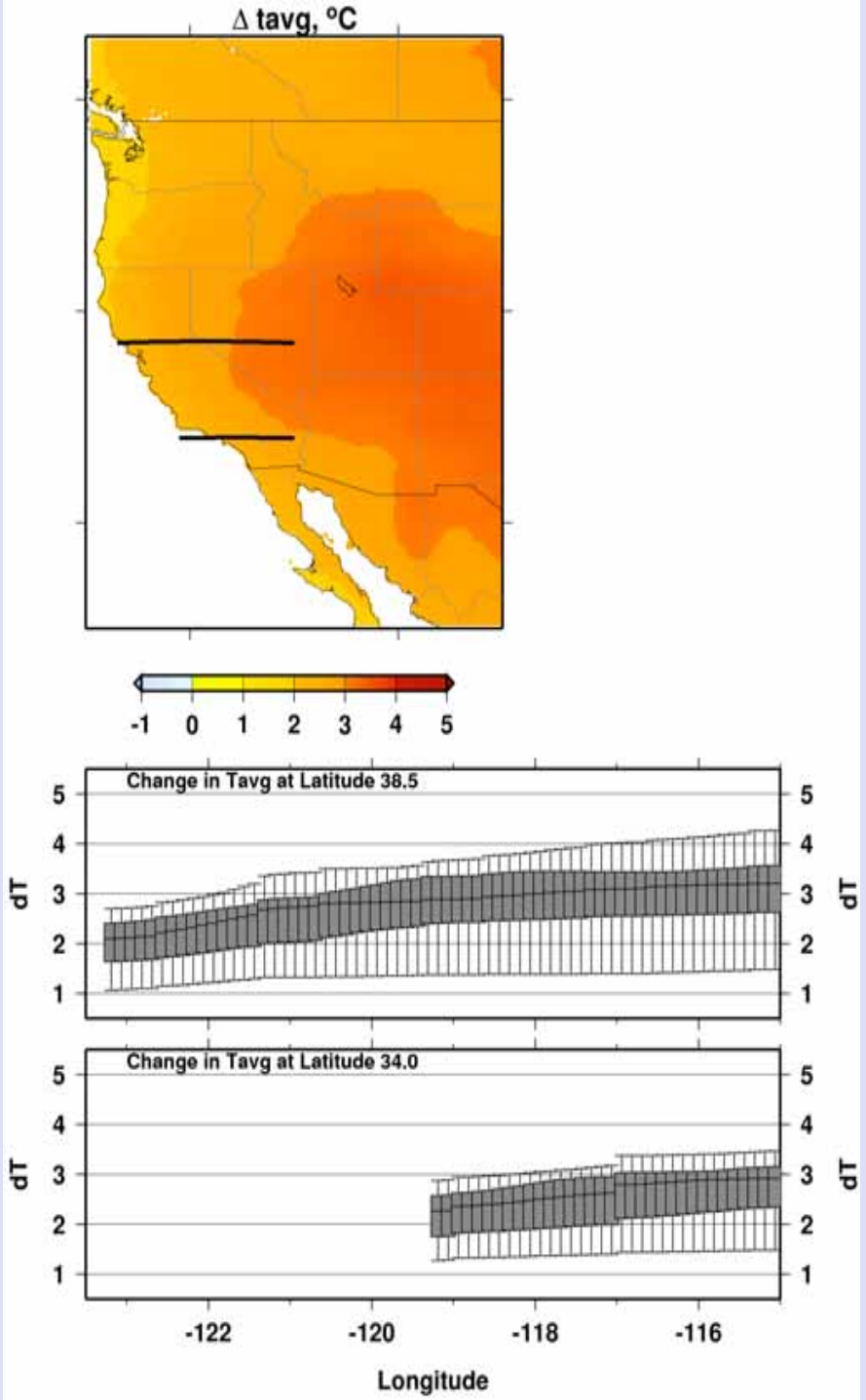
Regional dynamical experiments using
SRES A2 simulations from NCAR CCSM3, GFDL CM2.1


July daily average temperature at Sacramento, 16 models
A2 individual runs
A2 95% C.I.
B1 individual runs
B1 95% C.I.
Degrees C
Degrees F
34
32
30
28
26
24
22
94
92
90
88
86
84
82
80
78
76
74
72
70
1950
2000
2050
2100
Year
Period 1: 1985–1995
Period 2: 2062–2072

2063-2072 vs. historical annual temperature change 16 BCSD downscaled simulations

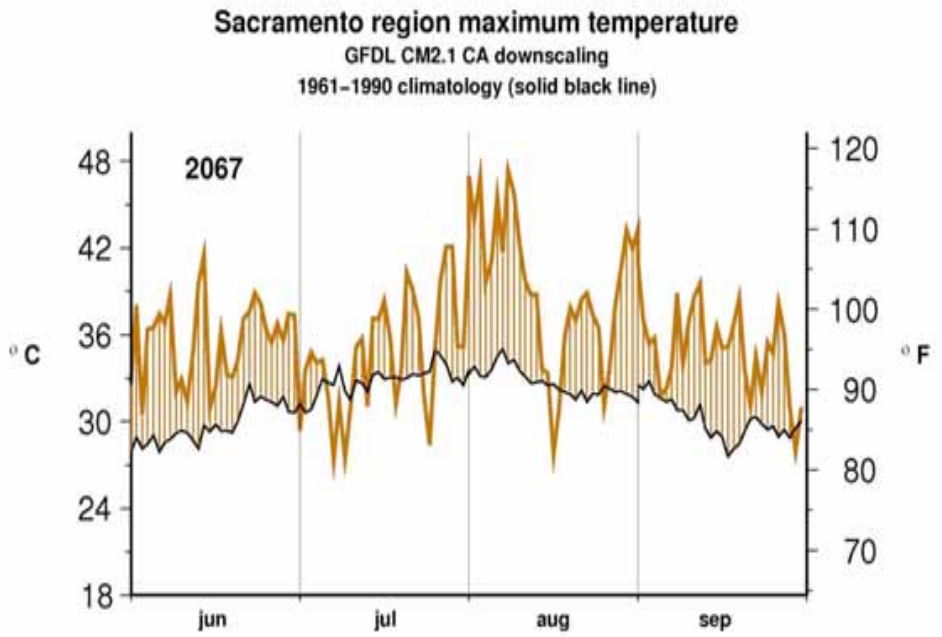
16 GCMs, A2 scenario.
2063-2072 minus 1986-1995.

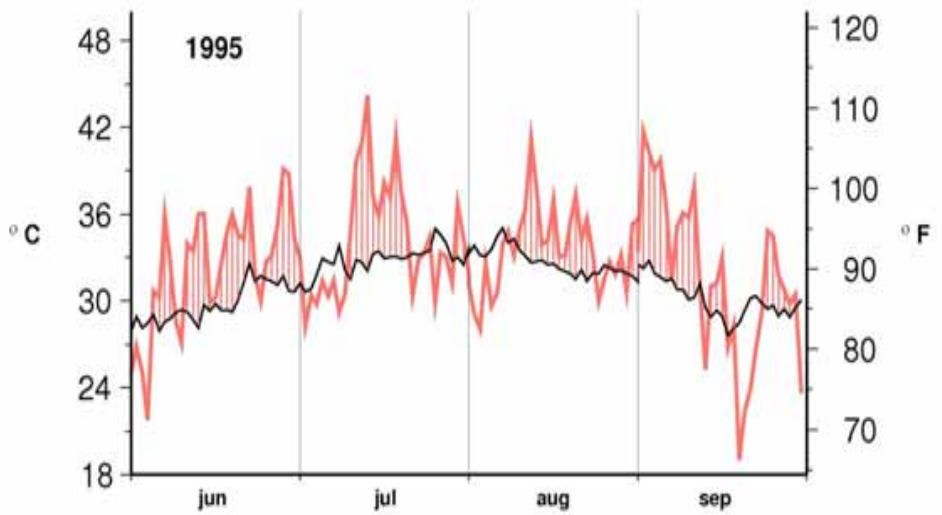
Map shows median temperature change, 16 projections
box-whisker plots show quartiles
of the 16 projections across 2 transects

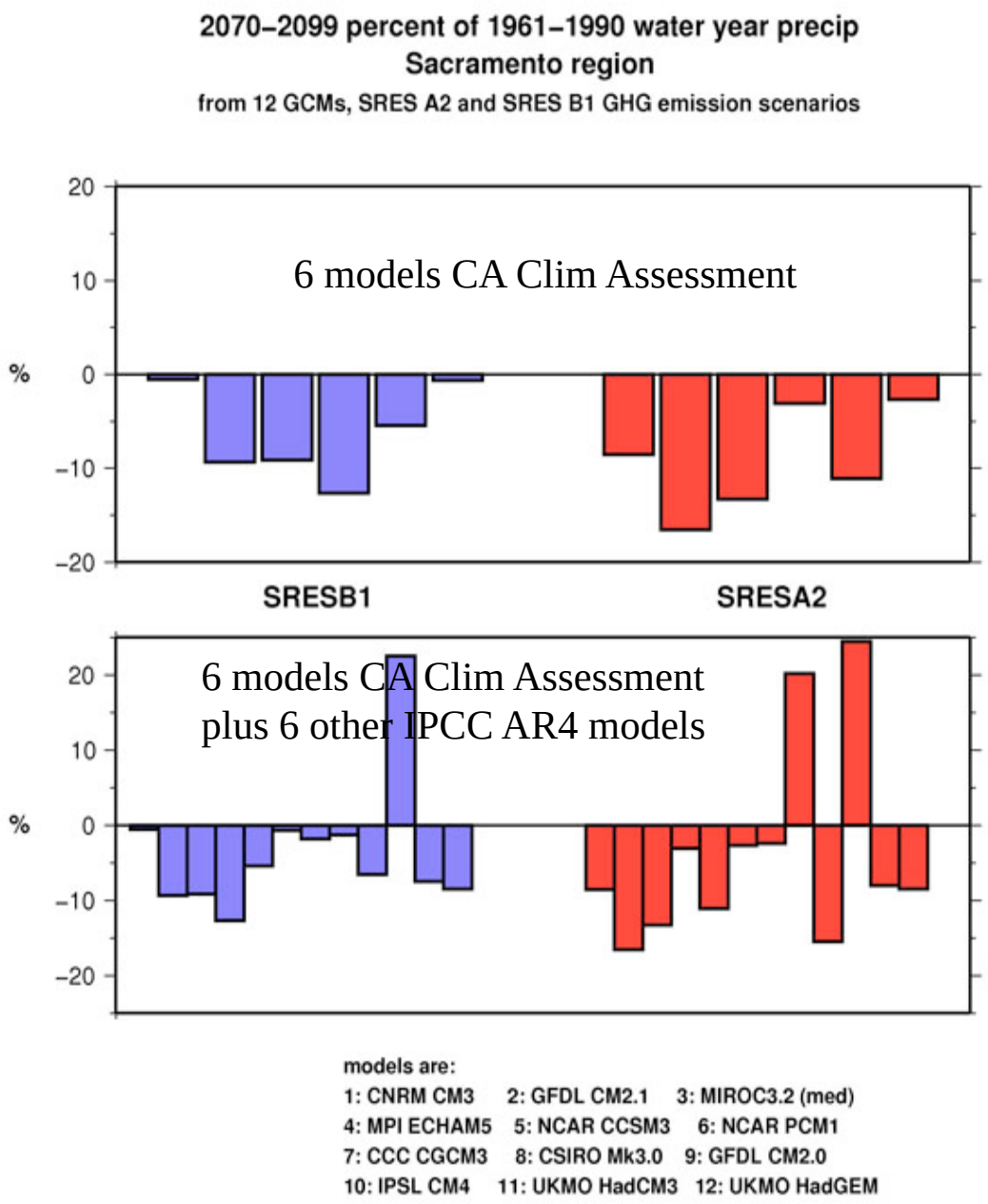


2 warm summers, Sacramento
hot days get hotter
hot spells get longer

summer daily maximum temp
CA downscaled GFDL A2 simulation
Model years 2067 and 1995







6 climate models employed in the Scenarios Assessment were heavily shaded toward drying in central California.

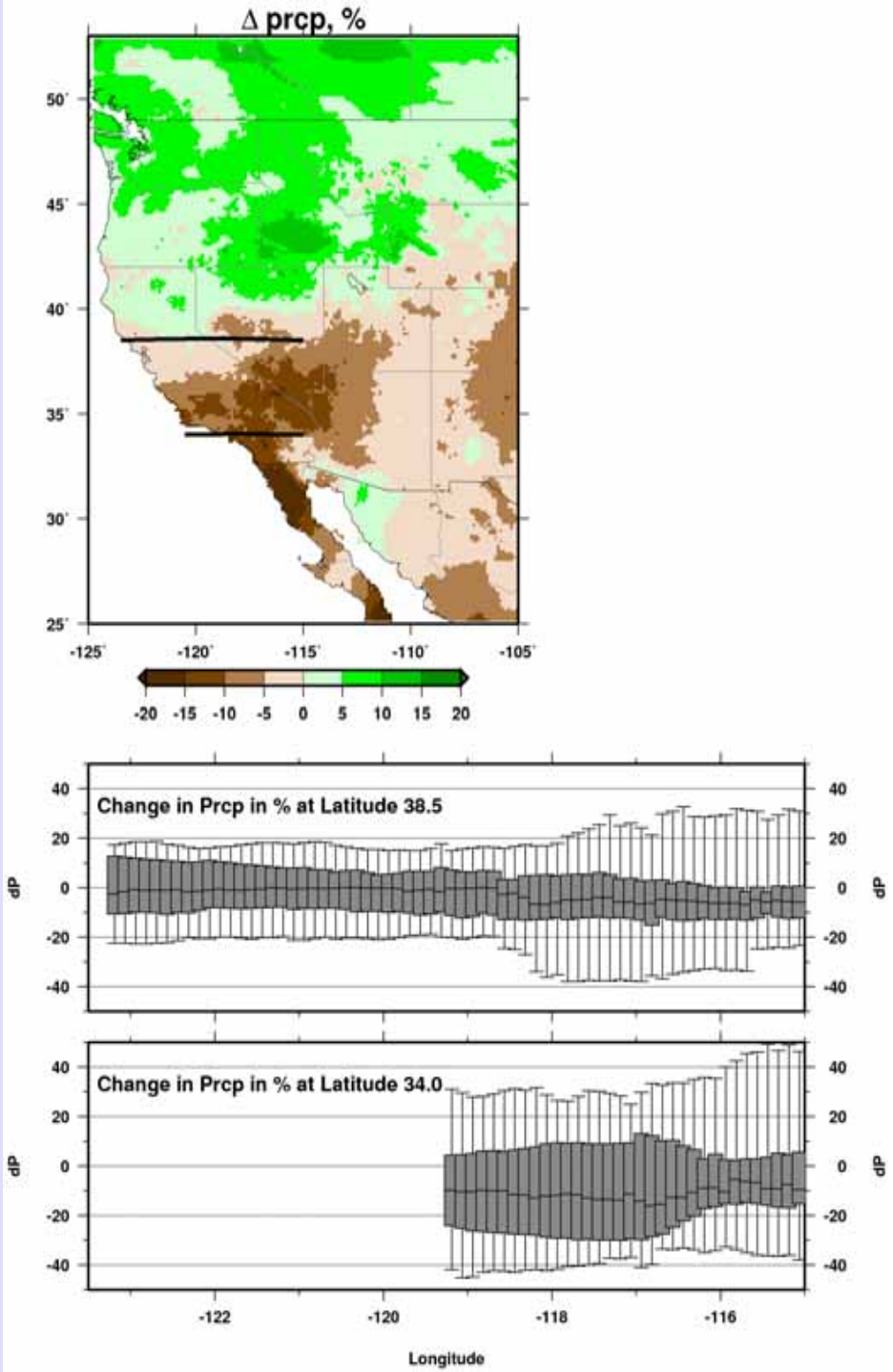
A larger set of 12 climate IPCC models do contain two simulations having wetter conditions at end of 21st Century, but the consensus reinforces concerns over a drier future.

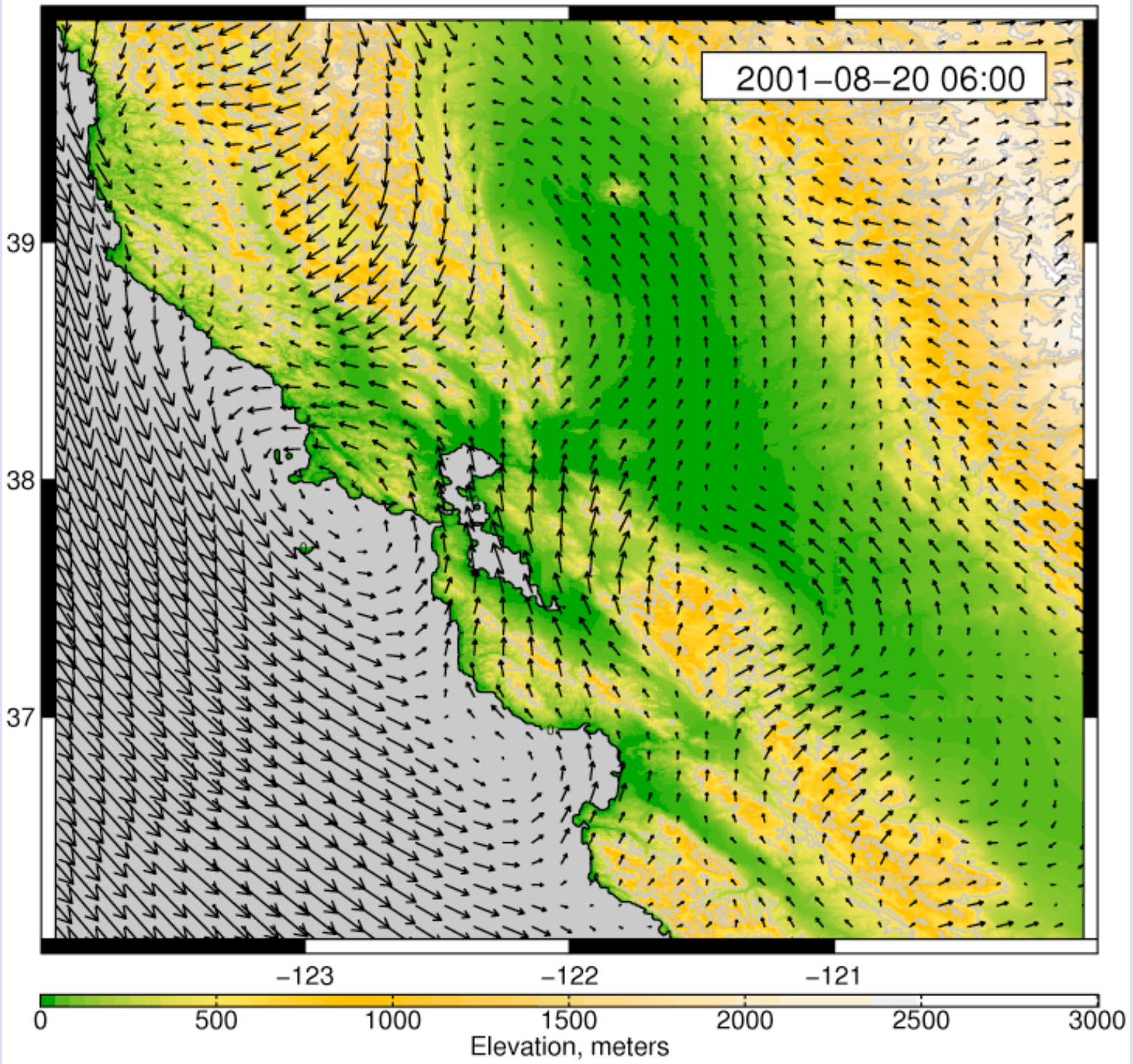
In Southern California, magnitude of drying tendencies was increased

2063-2072 vs. historical annual precipitation change across 2 transects BCSD downscaled simulations

16 GCMs, A2 scenario.
2063-2072 minus 1986-1995.

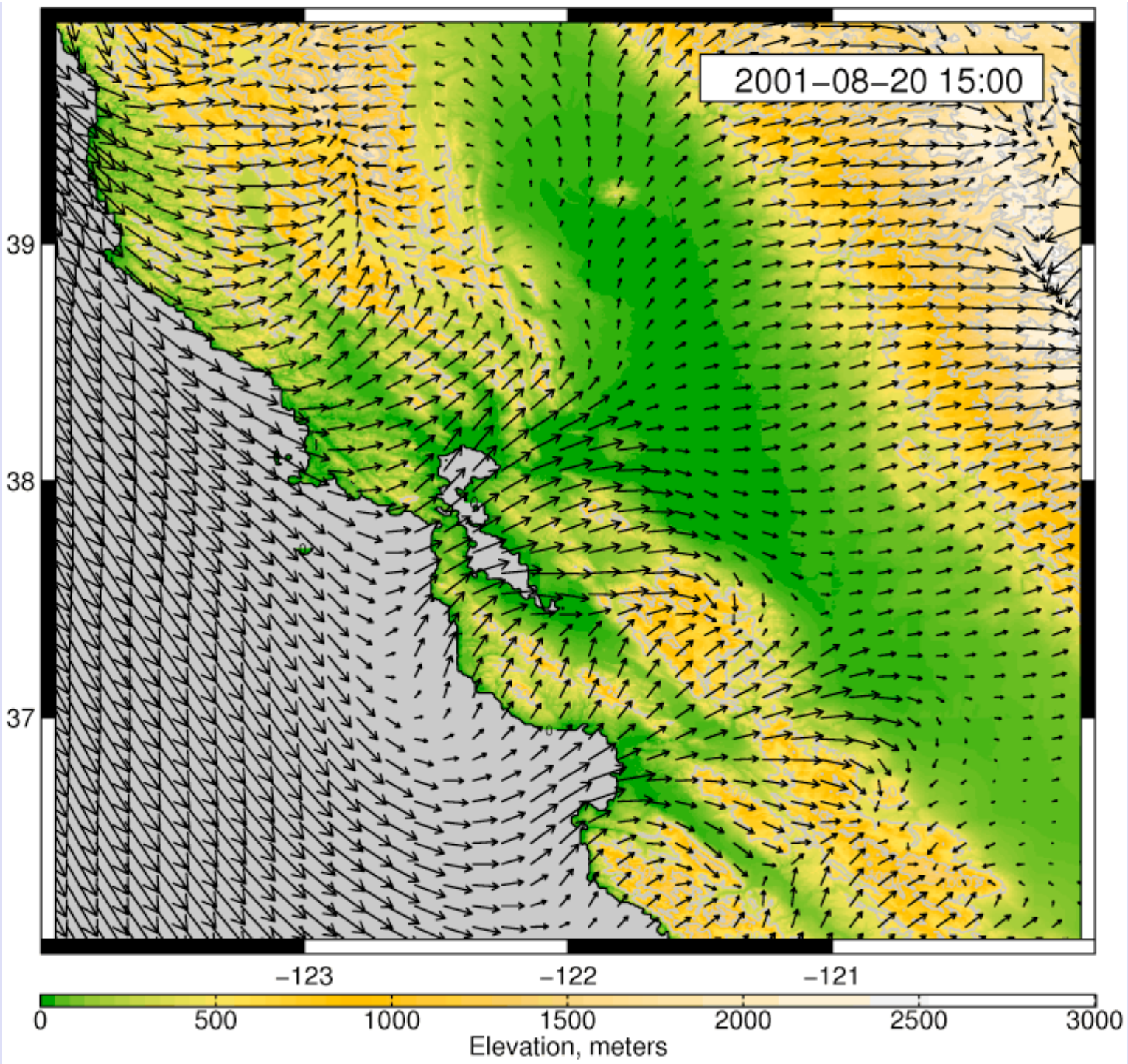
map shows median temperature change, 16 projections
box-whisker plots show quartiles
of the 16 projections across 2 transects

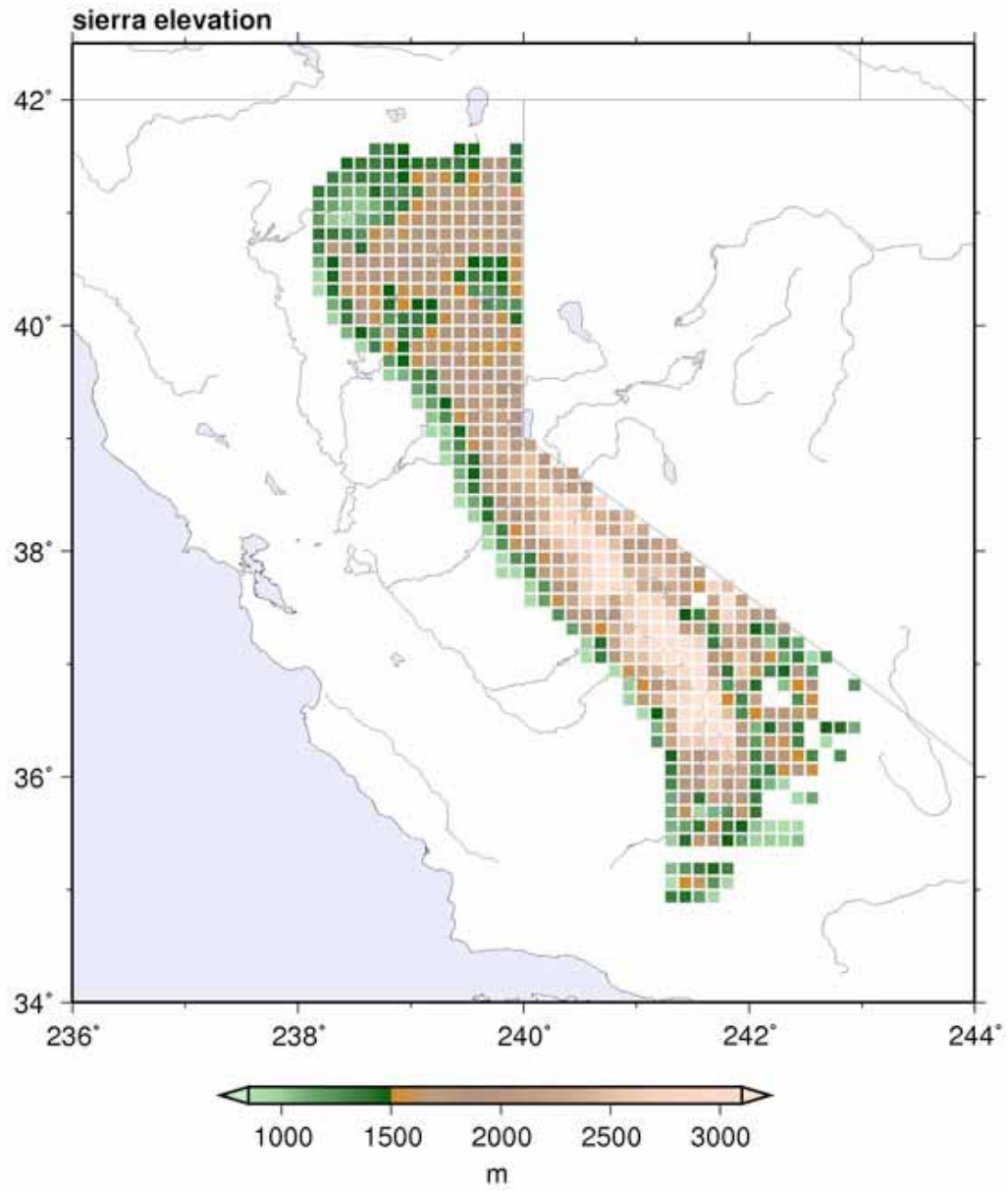




10 km hourly surface winds key to understand coast-inland climate response

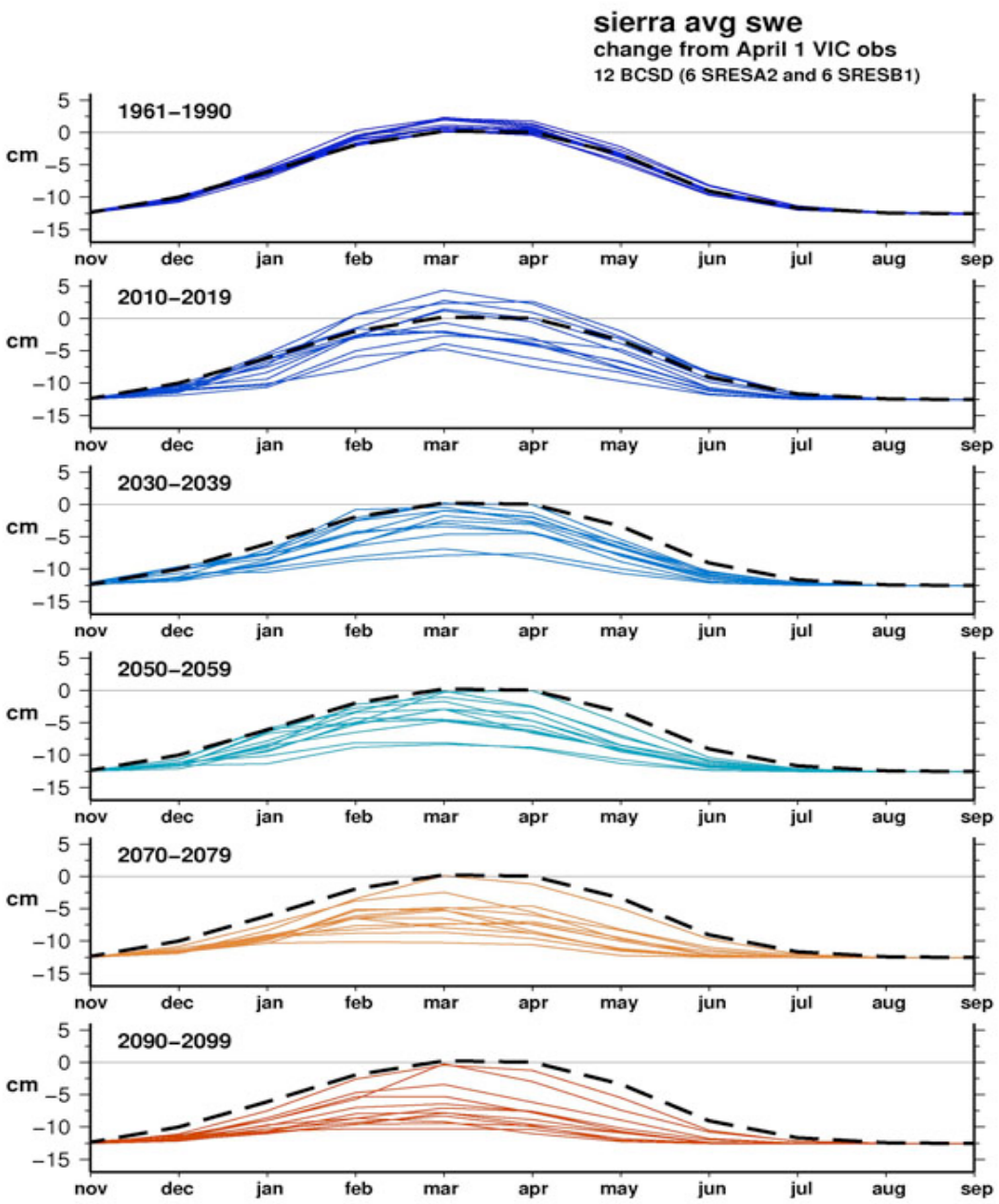
RSM Historical CArD10 Reanalysis


2001–08–20 15:00
39
38
37
–123
–122
–121
0
500
1000
1500
2000
2500
3000
Elevation, meters



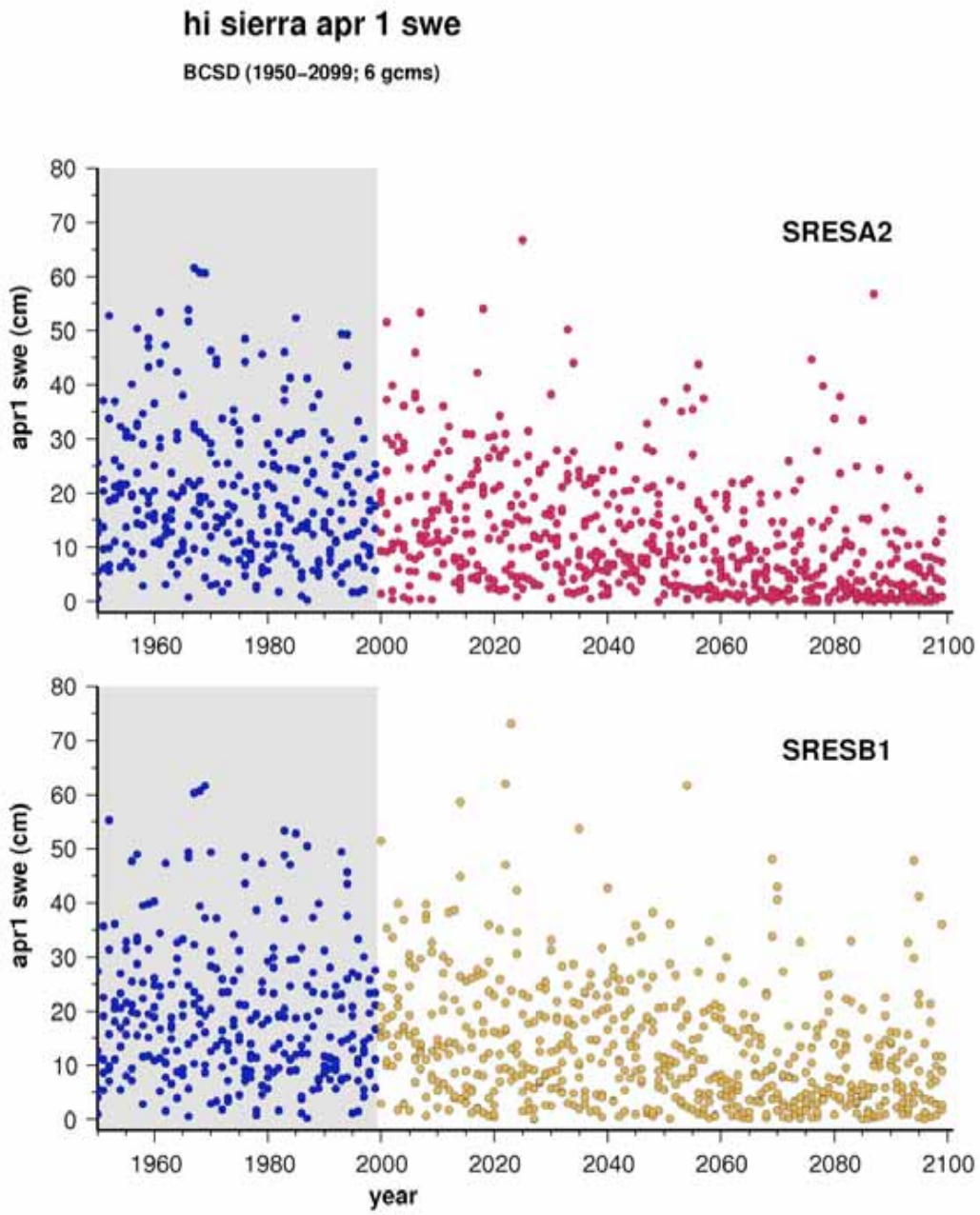
consider
aggregate Sierra Nevada
Snow Water Equiv (SWE)
elevations 800-3500m

from 9 GCM's
downscaled via BCSD
calculated using VIC
hydrological model



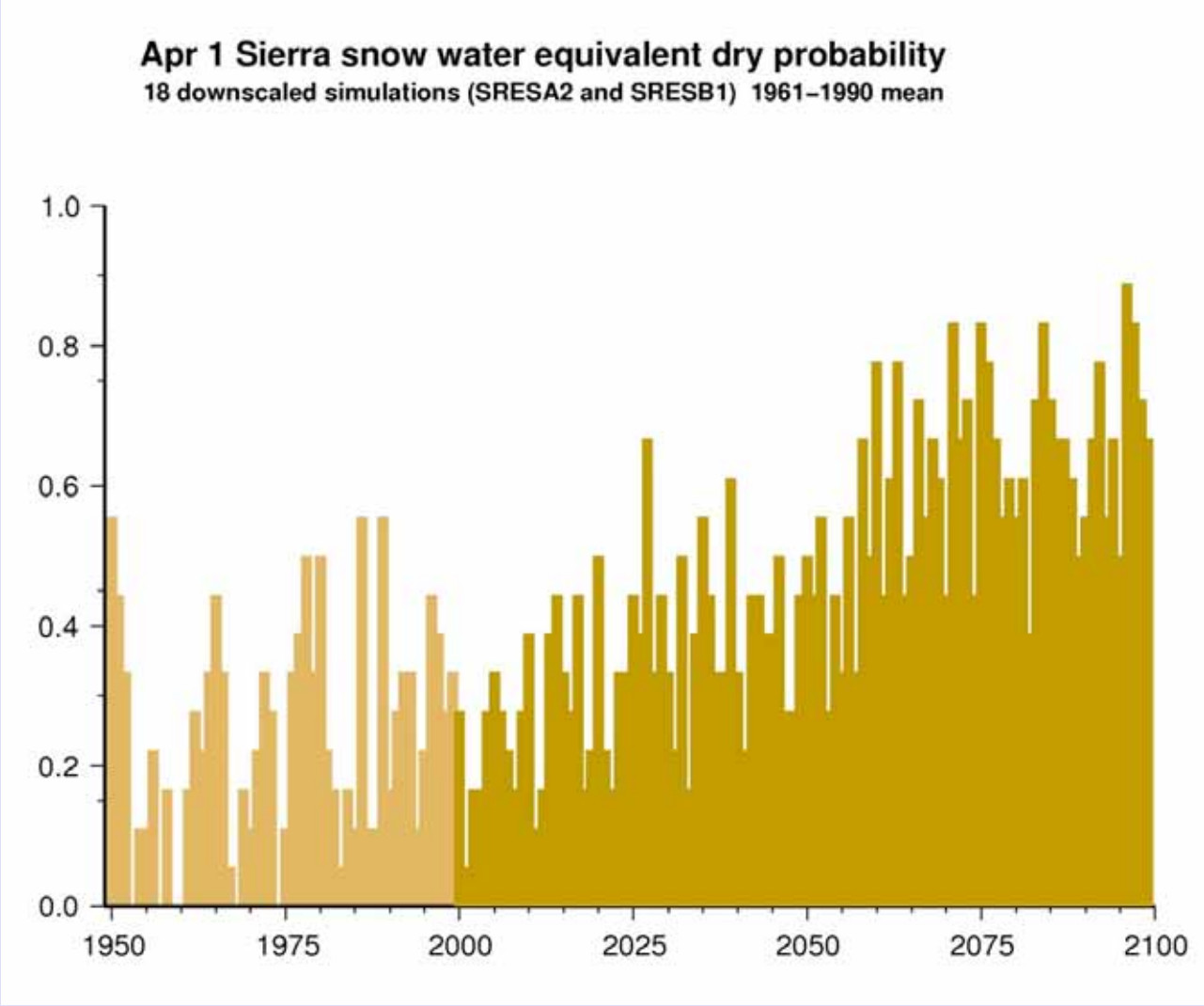
projected decline of SWE through the 21st Century

because of warming by 2070 Sierra SWE rarely, if ever, reaches Its historical mean levels



by 2050, occurrences of cases with minimal Sierra Nevada spring SWE is much more frequent, especially in A2 scenario simulations

An educated guess: Probability of Low Sierra Nevada Snow



Summary

Work in progress—regional model runs underway

evaluation, bias correction, analysis still to do

Dynamical model ensemble

limited to 10yr segments from 2 GCMs
10km horiz grid size approaches resolution needed for applications
hourly samples better able to describe diurnal structure and extreme events

but, other work is also underway *(Linda Mearns et al; Phil Mote et al)*

Statistical downscaling

limited to temperature and precipitation, daily samples
provides continuous historical and 21st Century record
several GCMs have been downscaled
see Ed Maurer's talk

Emissions Scenarios are limited and not weighted

New GCM simulations to come for IPCC AR5